Hazard Elimination Project Evaluation

Project Log # 200608079

Hazard Elimination Project W-4423

Evaluation of the Widening of Both Off-Ramps at the Interchange of SR 1728 (Wade Ave) at SR 1664 (Blue Ridge Rd) to Provide an Additional Turn Lane Wake County

Documents Prepared By:

Safety Evaluation Group
Traffic Safety Systems Management Section
Traffic Engineering and Safety Systems Branch
North Carolina Department of Transportation

Principal Investigator

Carrie L. Simpson, PE

Traffic Safety Project Engineer

1/3/08
Date

Hazard Elimination Project Evaluation Documentation

Subject Location

Evaluation of Hazard Elimination Project W-4423 –
SR 1728 (Wade Ave) at SR 1664 (Blue Ridge Rd) Off-Ramps in Wake County.

Project Information and Background from the Project File Folder

The safety countermeasure chosen for the subject location was the widening of both off-ramps at the interchange of SR 1728 (Wade Ave) at SR 1664 (Blue Ridge Rd) to provide an additional turn lane. Adding additional lanes for both off-ramps also required signal revisions, including signal head shifts for the eastbound off-ramp and bringing dual right turn lanes under signal control for the westbound off-ramp. Prior to the project, both the westbound and eastbound off-ramps had exclusive left and right turn lanes.

At the westbound off-ramp intersection, Blue Ridge Rd northbound has two through lanes and one left turn lane and Blue Ridge Rd southbound has two through lanes. At the eastbound off-ramp intersection, Blue Ridge Rd northbound has two through lanes and one right turn lane and Blue Ridge southbound has two through lanes and one left turn lane. Both intersections are controlled by a traffic signal and the speed limit is 45 mph for both directions of travel on Blue Ridge Rd. In the vicinity of the exit, Wade Ave has four lanes and the speed limit is 55 mph.

The initial crash analysis was conducted from November 1, 1994 through October 31, 1997 and included 30 crashes. All 30 of these crashes were Rear-End Crashes considered correctable by the countermeasure. According to the problem statement, the Rear-End Crashes for both eastbound and westbound off-ramps were caused by AM and PM peak hour conditions that resulted in extensive vehicle delays. The countermeasure was also meant to provide greater relief to event traffic in the vicinity of the RBC Center.

The final completion date for the improvement at the subject intersection was on August 31, 2002 with a total cost of $358,000.

Naive Before and After Analysis

After reviewing the hazard elimination project file folder along with all the crashes at the subject location, the crash data omitted from this analysis to consider for an adequate construction period was from June 1, 2002 through November 30, 2002. The before period consisted of reported crashes from January 1, 1998 through May 31, 2002 (4 years, 5 months) and the after period consisted of reported crashes from December 1, 2002 through April 30, 2007 (4 years, 5 months). The ending date for this analysis was determined by the available crash data at the time the crash analysis was completed.
The treatment data includes all crashes within 150 feet of the subject intersections and all crashes on the subject exit ramps. Please see attached *Location Map* and *Aerial Photos* for further details. Also see the attached *Collision Diagrams* for more detailed visual depiction of the crash data.

The following data tables depict the Naive Before and After Analysis for the treatment location. The data is provided for the eastbound ramp intersection, the westbound ramp intersection, and as an aggregate of both intersections. Please note that Rear End Crashes on the exit ramps were the target crashes for the applied countermeasure.

Treatment Information – Both Ramp Intersections	**Before**	**After**	**Percent Reduction (-) Percent Increase (+)**
Total Crashes	144	100	-30.6%
Total Severity Index	3.53	3.53	0.0%
Target Crashes	60	34	-43.3%
Target Crashes Severity Index	2.73	1.87	-31.5%
Volume	93,700	85,500	-8.8%

Injury Summary – Both Ramp Intersections	**Before**	**After**	**Percent Reduction (-) Percent Increase (+)**
Total Injury Crashes	40	25	-37.5%
Fatal Crashes	0	0	N/A
Class A Crashes	1	1	0.0%
Class B Crashes	8	5	-37.5%
Class C Crashes	31	19	-38.7%
Property Damage Only (PDO) Crashes	104	75	-27.9%

The naive before and after analysis at both ramp intersections resulted in a 31 percent decrease in Total Crashes, a 43 percent decrease in Target Crashes, and a 9 percent decrease in Average Daily Traffic (ADT). In addition, Total Injury Crashes decreased by 38 percent and PDO Crashes decreased by 28 percent.

The before period ADT year was 2000 and the after period ADT year was 2005. Volumes are not actual ramp counts, as they were unavailable. Instead, volumes of Wade Ave and Blue Ridge Rd at the subject location were used. It was assumed that the ramp ADT would increase proportionally.

Treatment Information – Eastbound Ramp Intersection	**Before**	**After**	**Percent Reduction (-) Percent Increase (+)**
Total Crashes	66	51	-22.7%
Total Severity Index	4.28	2.89	-32.5%
Target Crashes	23	16	-30.4%
Target Crashes Severity Index	3.25	1.46	-55.1%

Injury Summary – Eastbound Ramp Intersection	**Before**	**After**	**Percent Reduction (-) Percent Increase (+)**
Total Injury Crashes	20	13	-35.0%
Fatal Crashes	0	0	N/A
Class A Crashes	1	0	-100.0%
Class B Crashes	4	3	-25.0%
Class C Crashes	15	10	-33.3%
Property Damage Only (PDO) Crashes	46	38	-17.4%

The naive before and after analysis at the eastbound ramp intersection resulted in a 23 percent decrease in Total Crashes and a 30 percent decrease in Target Crashes. In addition, Total Injury Crashes decreased by 35 percent and PDO Crashes decreased by 17 percent.

Treatment Information – Westbound Ramp Intersection	**Before**	**After**	**Percent Reduction (-) Percent Increase (+)**
Total Crashes	78	49	-37.2%
Total Severity Index	2.90	4.21	45.2%
Target Crashes	37	18	-51.4%
Target Crashes Severity Index	2.40	2.23	-7.1%

Injury Summary – Westbound Ramp Intersection	**Before**	**After**	**Percent Reduction (-) Percent Increase (+)**
Total Injury Crashes	20	12	-40.0%
Fatal Crashes	0	0	N/A
Class A Crashes	0	1	N/A
Class B Crashes	4	2	-50.0%
Class C Crashes	16	9	-43.8%
Property Damage Only Crashes	58	37	-36.2%

The naive before and after analysis at the westbound ramp intersection resulted in a 37 percent decrease in Total Crashes and a 51 percent decrease in Target Crashes. In addition, Total Injury Crashes decreased by 40 percent and PDO Crashes decreased by 36 percent.

Results and Discussion

The naive before and after analysis involving the comparison of treatment actual before data versus treatment actual after data resulted in a 31 percent decrease in Total Crashes and a 43 percent decrease in Target Crashes when analyzing both ramp intersections. The Total Severity Index remained unchanged and the Target Crash Severity decreased by 43 percent. The summary results above demonstrate that the treatment location appears to have had a decrease in the number and severity of Total and Target Crashes from the before to the after period.

The calculated benefit to cost ratio for this project is 2.50 considering total crashes. The benefit to cost ratio considering only target crashes is 1.58. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related to the project are not considered in this analysis. The costs of the project include the actual construction costs as well as the increase in annual maintenance costs.

The crash data was also analyzed separately for each of the ramp intersections. At the eastbound ramp intersection, the naive before and after analysis resulted in a 23 percent decrease in Total Crashes and a 33 percent decrease in the Total Severity Index. Target Crashes on the eastbound off-ramp decreased by 30 percent, from 23 crashes in the before period to 16 crashes in the after period. The Target Crash Severity also decreased by 55 percent. In both the before and after period, a majority (over 90%) of the Target Crashes were low-severity crashes (Class-C or PDO Crashes).

A non-Target crash pattern exists at the eastbound ramp intersection involving left turning vehicles from southbound Blue Ridge Rd failing to yield the right-of-way to oncoming vehicles on northbound Blue Ridge Rd. This pattern remained in the after period, although it had decreased by 36 percent from 14 crashes in the before period to 9 crashes in the after period. In the before period, all 4 of the Class-B injury crashes at the intersection and a Class-C injury crash were part of this crash pattern. In the after period, there were 2 Class-C injury crashes resulting from this crash pattern.

At the westbound ramp intersection, the naive before and after analysis resulted in a 37 percent decrease in Total Crashes and a 45 percent increase in the Total Severity Index. Target Crashes on the westbound off-ramp decreased by 51 percent, from 37 crashes in the before period to 18 crashes in the after period. The Target Crash Severity also decreased by 7 percent. As with the eastbound ramp intersection, in both the before and after period, a majority (over 90%) of the Target Crashes were low-severity crashes.

A non-Target crash pattern exists at the westbound ramp intersection involving left turning vehicles from the exit ramp being hit by northbound Blue Ridge Rd that ran the signal. This pattern was reduced by 57 percent from 14 crashes in the before period to 6 crashes in the after period. In the before period, all 4 of the Class-B injury crashes at the intersection and 4 Class-C injury crashes were part of this crash pattern. In the after period, there were 3 injury crashes resulting from this pattern, including the only Class-A injury crash at the intersection, one Class-B injury crash, and one Class-C injury crash.

As previously stated, the countermeasure was implemented due to AM and PM peak hour conditions that resulted in long queues of traffic and Rear-End Crashes for both eastbound and westbound off-ramps. To determine whether the countermeasure alleviated crashes during the peak hours, we examined Total and Target Crashes during these time periods. Please see the tables below.

Total Crashes During Peak Hours	AM Peak 7-9 AM	PM Peak 4-6 PM	Peak Hours Total
Before	26 (18%)	24 (17%)	50 (35%)
After	14 (14%)	21 (21%)	35 (35%)

Note: Percentages in ( ) represent the percentage of Total Crashes.

The number of Total Crashes that occurred during peak hours decreased by 30 percent from the before to the after period, although the percentage of Total Crashes that occurred in these hours remained the same. The largest decrease in Total Crashes occurred in the AM peak hours.

Target Crashes During Peak Hours	AM Peak 7-9 AM	PM Peak 4-6 PM	Peak Hours Target
Before	12 (20%)	5 (8%)	17 (28%)
After	6 (18%)	6 (18%)	12 (35%)

Note: Percentages in ( ) represent the percentage of Target Crashes.

The number of Target Crashes that occurred during peak hours decreased by 29 percent from the before to the after period, although the percentage of Target Crashes that occurred in these hours increased slightly. As with Total Crashes, the largest decrease in Target Crashes occurred in the AM peak hours.

As shown in the tables above, the crash frequency in the Peak Hours decreased but the percentage of crashes in these hours remained the same or increased. This indicates that while the treatment was effective in reducing crashes, there is no evidence to suggest a more positive effect on Peak Hour Crashes than on crashes at any other time of day.

Please see the attached *Treatment Site Photos*. Photos are provided for all approaches of both treatment intersections.

As the Safety Evaluation Group completes additional spot safety reviews for this type of countermeasure, we will be able to provide objective and definite information regarding actual crash reduction factors for this type of intersection.

TOTAL BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: Wade at Blue Ridge
COUNTY: Wake
FILE NO.: W4423

BY: CLS
DATE: 11/19/2007

DETAILED COST: TYPE IMPROVEMENT - Widening of Ramps For Additional Lanes

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	$358,000	20	0.102	$36,463
	$0	0	0.000	$0
Right-of-Way	$0	0	0.000	$0
TOTALS	$358,000	20	0.102	$36,463

ESTIMATED INCREASE IN ANNUAL MAINT. COST = $200 *Per Pre-Project Benefit-Cost Analysis*
ESTIMATED INCREASE IN ANNUAL UTILITY COST = $0

TOTAL ANNUAL COST= $36,663
TOTAL COST OF PROJECT= $358,000

COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	4.41	1	0.23	39	8.84	104	23.58	$384,898
AFTER	4.41	1	0.23	24	5.44	75	17.01	$293,311

Annual Benefits from Crash Cost Savings $91,587

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = $54,924

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 2.50

TOTAL COST OF PROJECT - $358,000 COMPREHENSIVE B/C RATIO - 2.50

TREATMENT BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: Wade at Blue Ridge
COUNTY: Wake
FILE NO.: W4423

BY: CLS
DATE: 11/19/2007

DETAILED COST: TYPE IMPROVEMENT - Widening of Ramps For Additional Lanes

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	$358,000	20	0.102	$36,463
	$0	0	0.000	$0
Right-of-Way	$0	0	0.000	$0
TOTALS	$358,000	20	0.102	$36,463

ESTIMATED INCREASE IN ANNUAL MAINT. COST = $200 *Per Pre-Project Benefit-Cost Analysis*
ESTIMATED INCREASE IN ANNUAL UTILITY COST = $0

TOTAL ANNUAL COST= $36,663
TOTAL COST OF PROJECT= $358,000

COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	4.41	0	0.00	14	3.17	46	10.43	$103,084
AFTER	4.41	0	0.00	4	0.91	30	6.80	$45,125

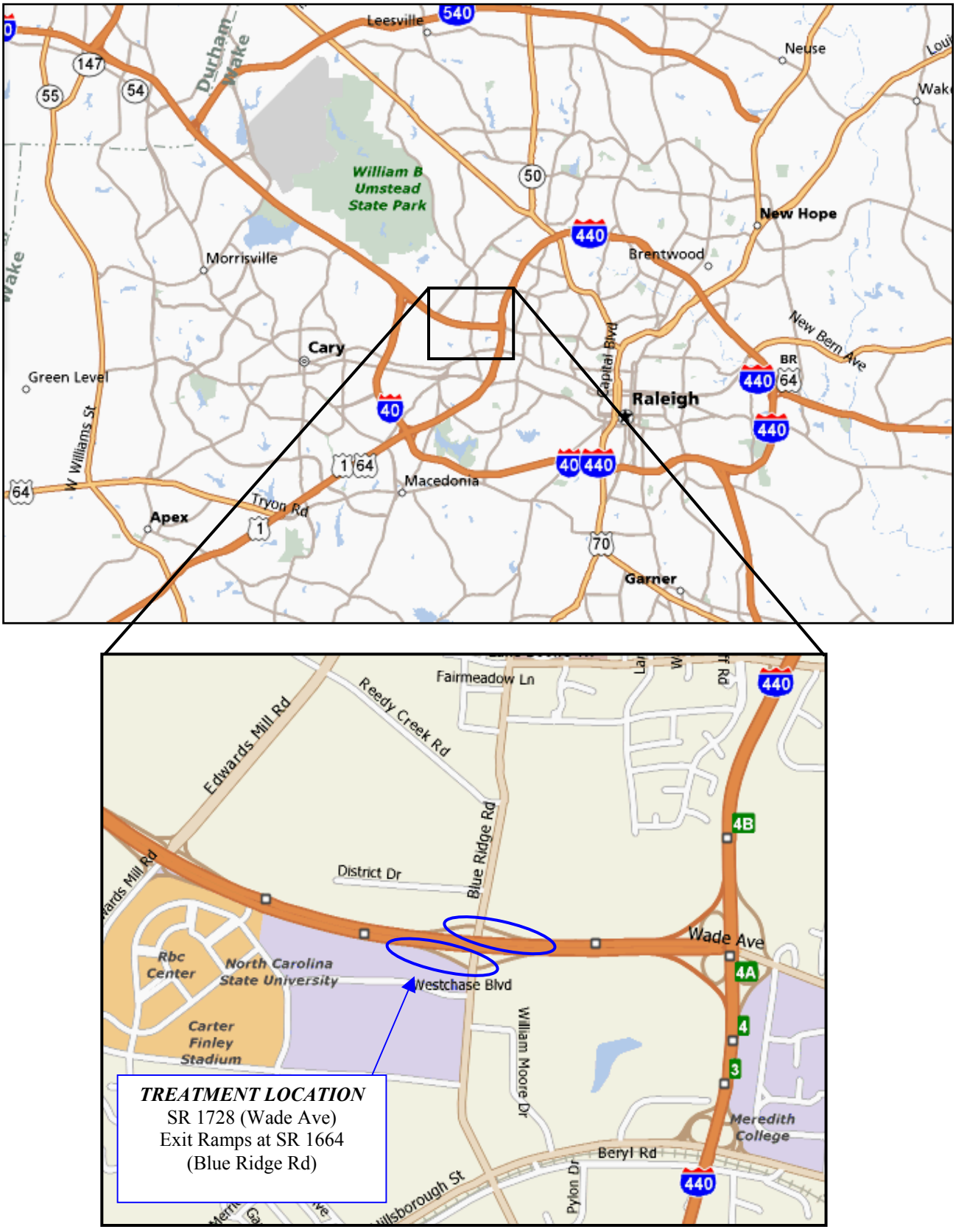
Annual Benefits from Crash Cost Savings $57,959

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = $21,296

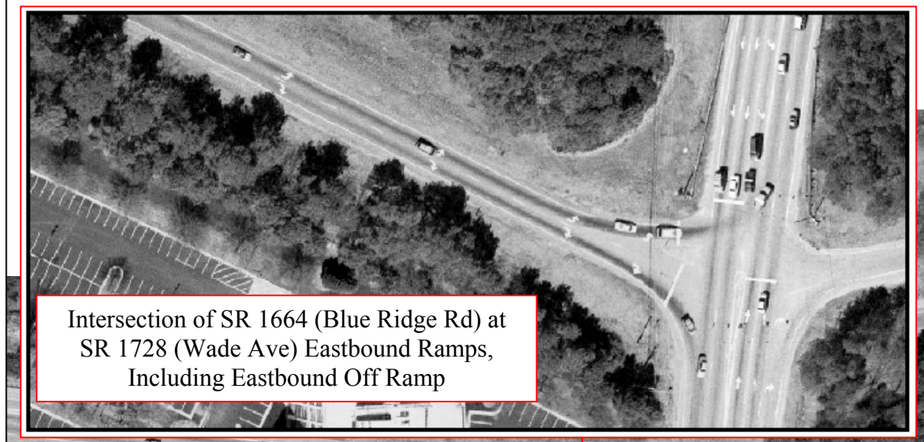
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 1.58

TOTAL COST OF PROJECT - $358,000 **COMPREHENSIVE B/C RATIO - 1.58**

Location Map
Hazard Elimination Project W-4423



2002 AERIAL PHOTO – BEFORE PERIOD



Intersection of SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Eastbound Ramps, Including Eastbound Off Ramp

Intersection of SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Westbound Ramps, Including Westbound Off Ramp

2006 AERIAL PHOTO – AFTER PERIOD

Intersection of SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Westbound Ramps, Including Westbound Off Ramp

Intersection of SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Eastbound Ramps, Including Eastbound Off Ramp

Treatment Photos (Taken on 12/10/2007)

Travelling westbound on SR 1728 (Wade Ave) approaching the SR 1664 (Blue Ridge Rd) Interchange.

Travelling on SR 1728 (Wade Ave) westbound off-ramp approaching SR 1664 (Blue Ridge Rd).

Treatment Photos (Taken on 12/10/2007)

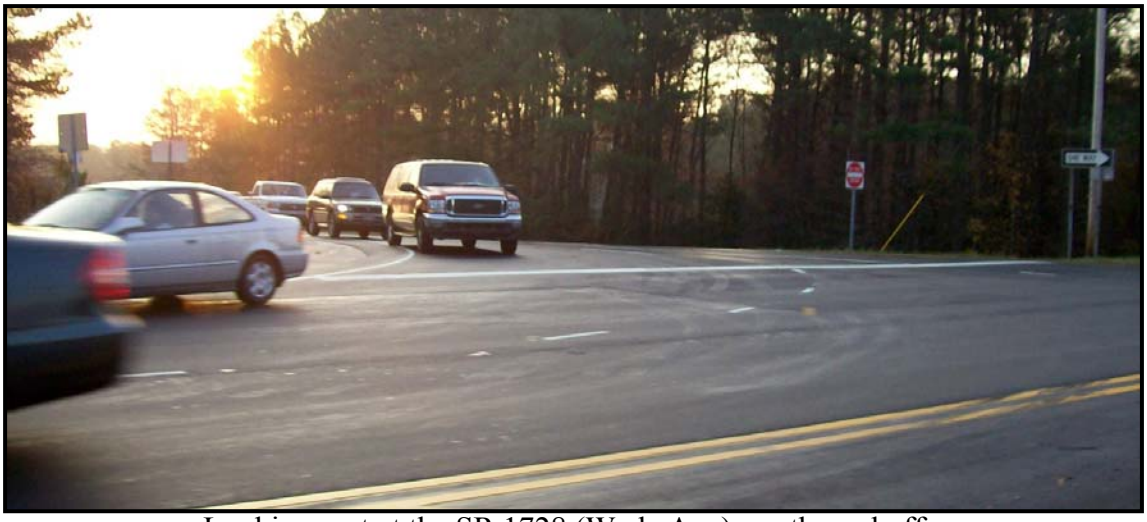
Travelling on SR 1728 (Wade Ave) westbound off-ramp approaching SR 1664 (Blue Ridge Rd).

Travelling on SR 1728 (Wade Ave) westbound off-ramp at the intersection with SR 1664 (Blue Ridge Rd).

Treatment Photos (Taken on 12/10/2007)

Travelling northbound on SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) westbound on/off ramps.

Travelling southbound on SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) westbound on/off ramps.



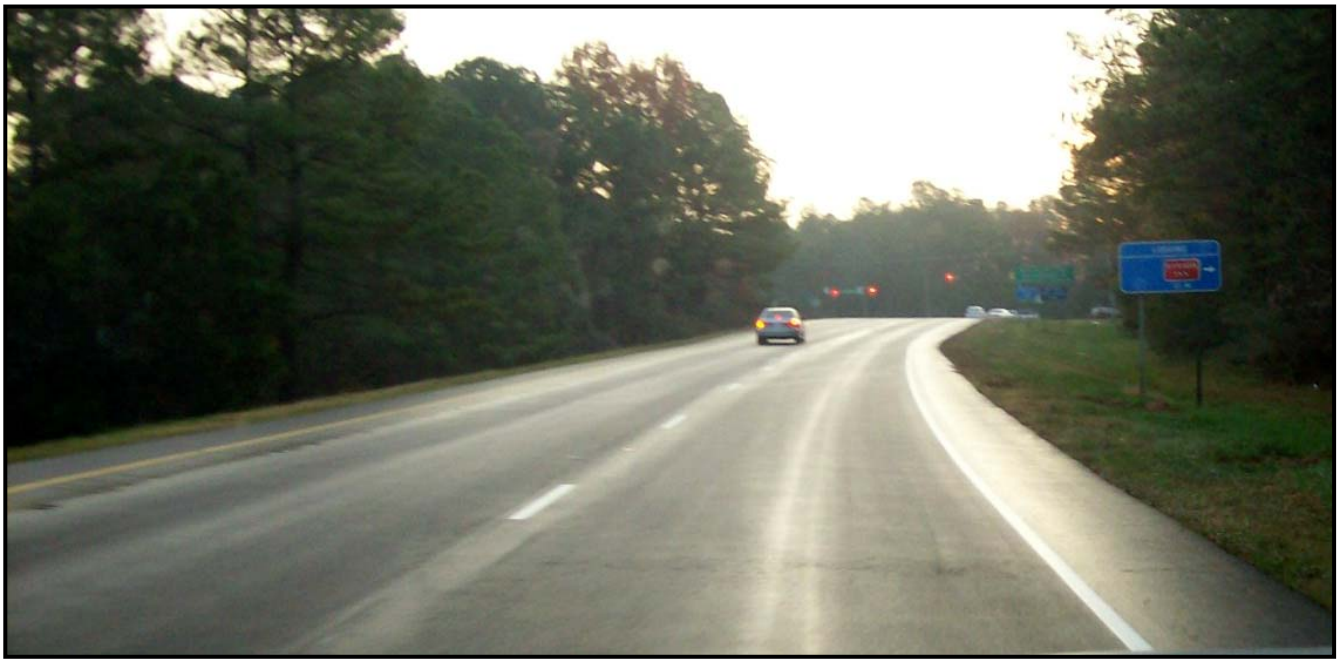
Looking east at the SR 1728 (Wade Ave) westbound off-ramps.

Treatment Photos (Taken on 12/10/2007)

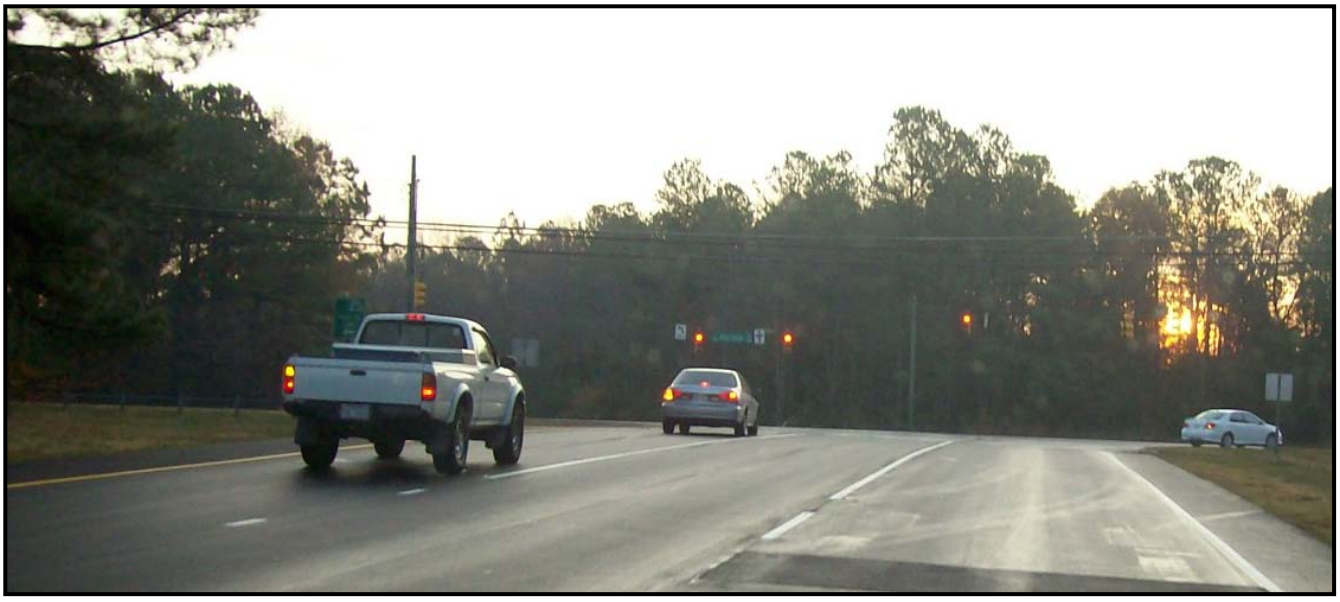
Travelling eastbound on SR 1728 (Wade Ave) approaching the SR 1664 (Blue Ridge Rd) Interchange.

Travelling on SR 1728 (Wade Ave) eastbound off-ramp approaching SR 1664 (Blue Ridge Rd).

Treatment Photos (Taken on 12/10/2007)

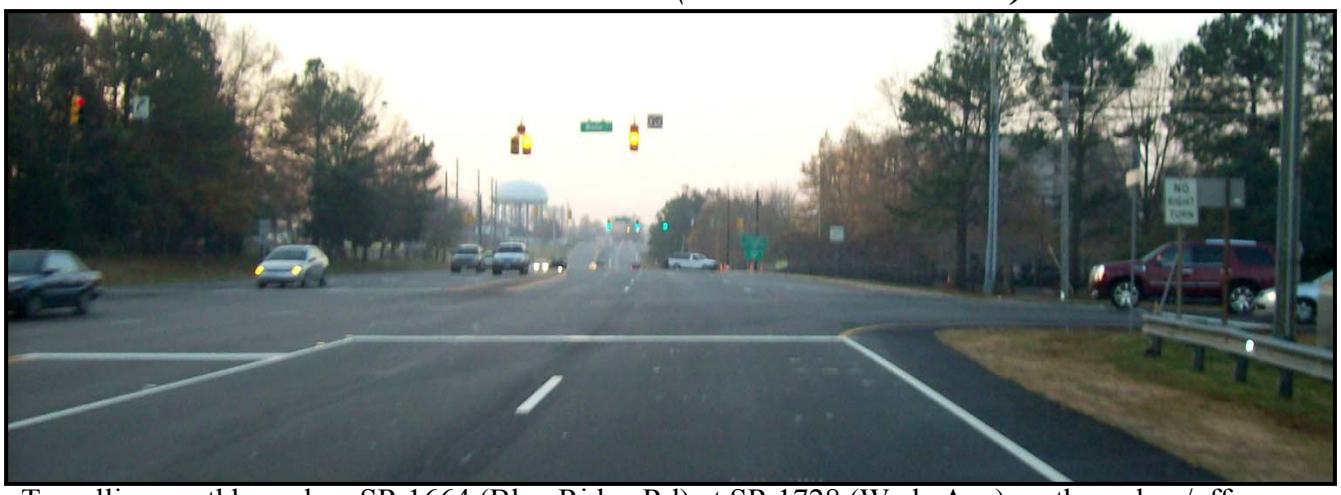


Travelling on SR 1728 (Wade Ave) eastbound off-ramp approaching SR 1664 (Blue Ridge Rd).



Travelling on SR 1728 (Wade Ave) eastbound off-ramp at the intersection with SR 1664 (Blue Ridge Rd).

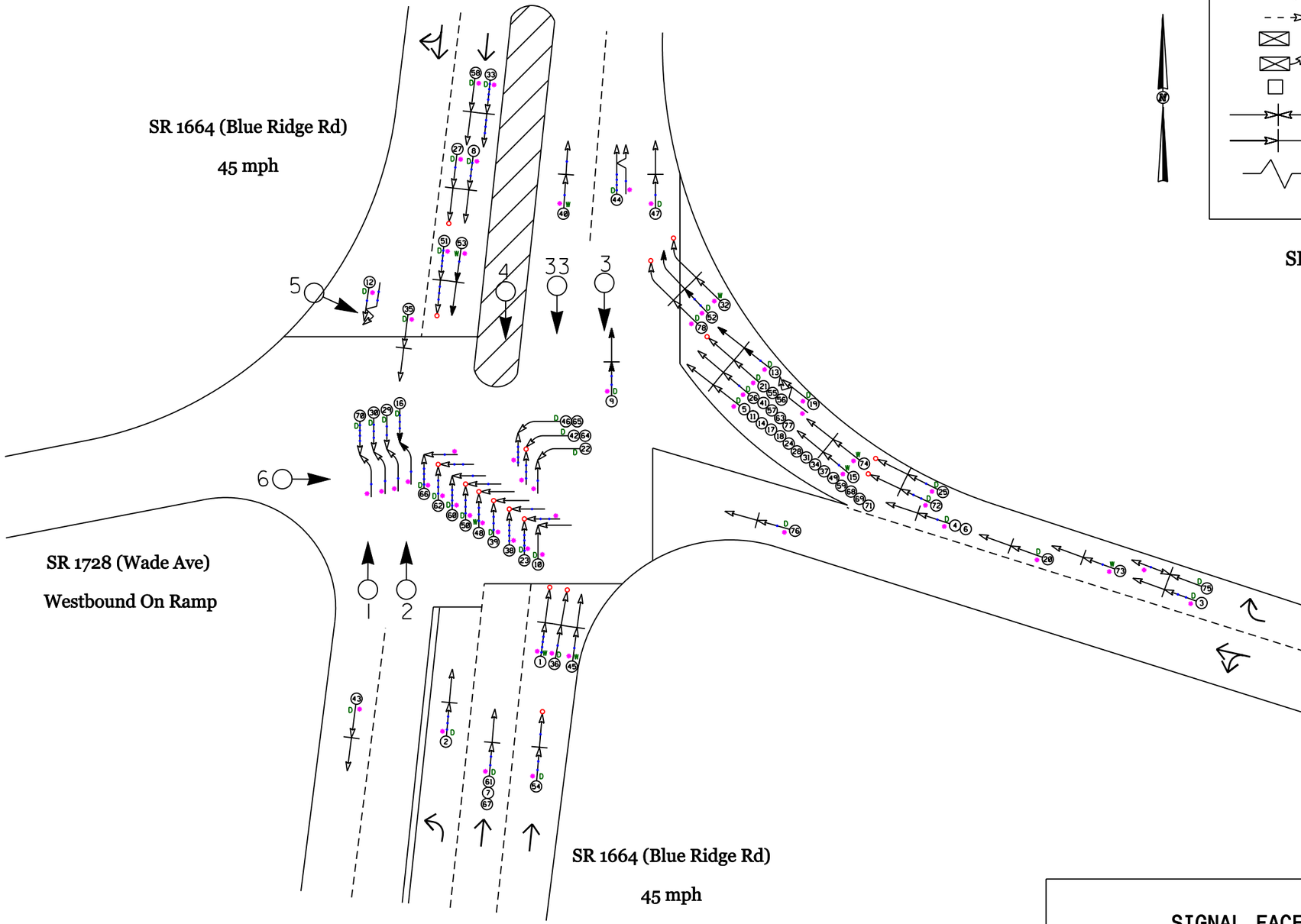
Treatment Photos (Taken on 12/10/2007)

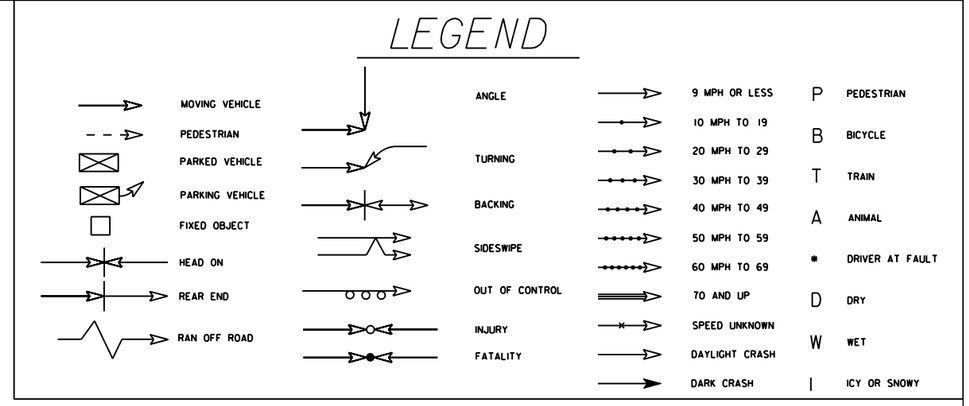


Travelling southbound on SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) eastbound on/off-ramps.

Travelling northbound on SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) eastbound on/off-ramps.

Looking west at the SR 1728 (Wade Ave) eastbound off-ramps.





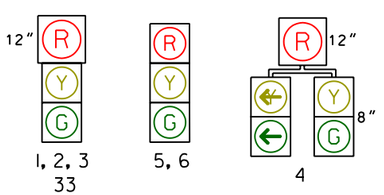
SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Westbound Exit

Wake County

Before Period

January 1, 1998 - May 31, 2002

SIGNAL FACE I.D.



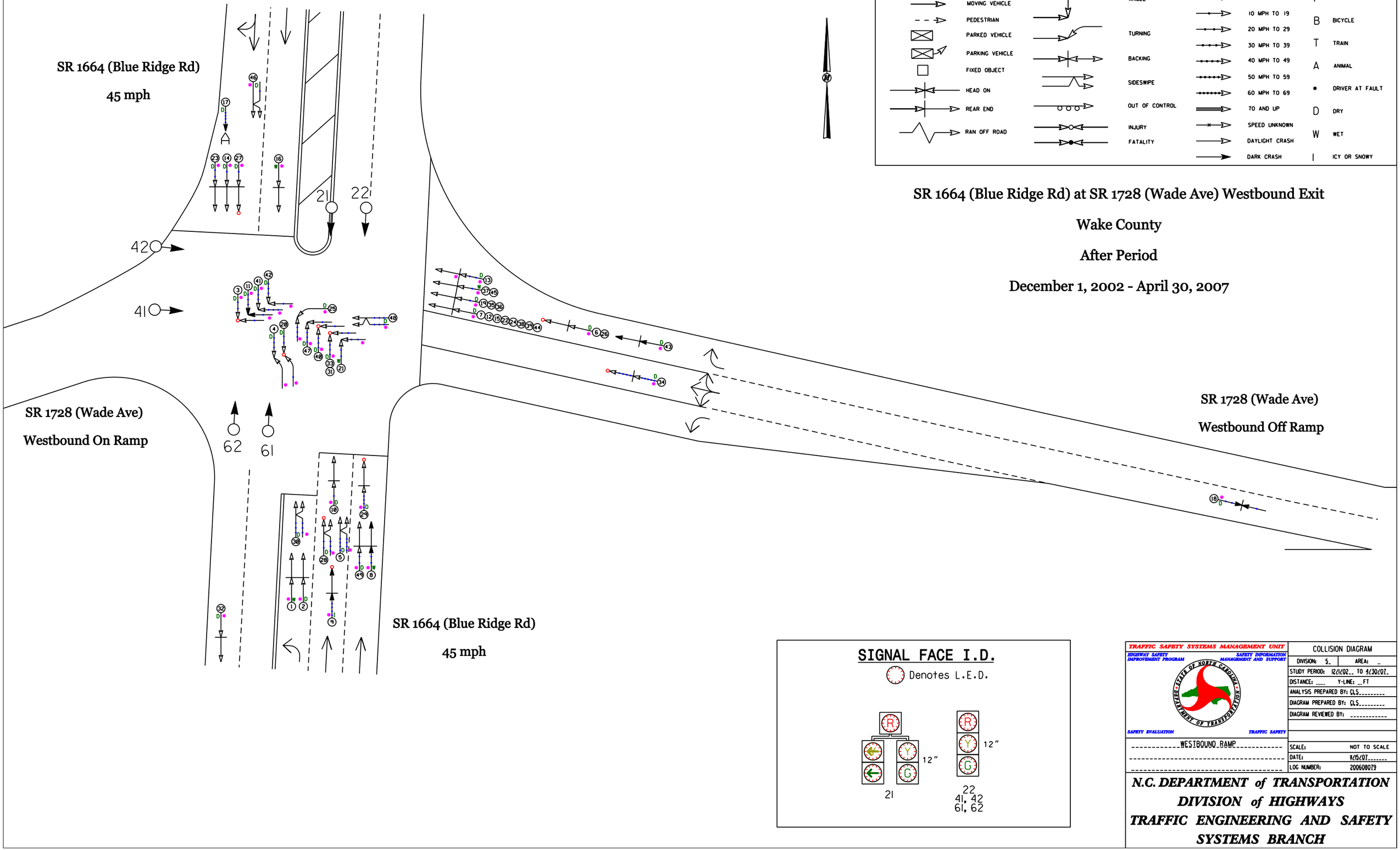
TRAFFIC SAFETY SYSTEMS MANAGEMENT UNIT
HIGHWAY SAFETY IMPROVEMENT PROGRAM
SAFETY INFORMATION MANAGEMENT AND SUPPORT
SAFETY EVALUATION
TRAFFIC SAFETY

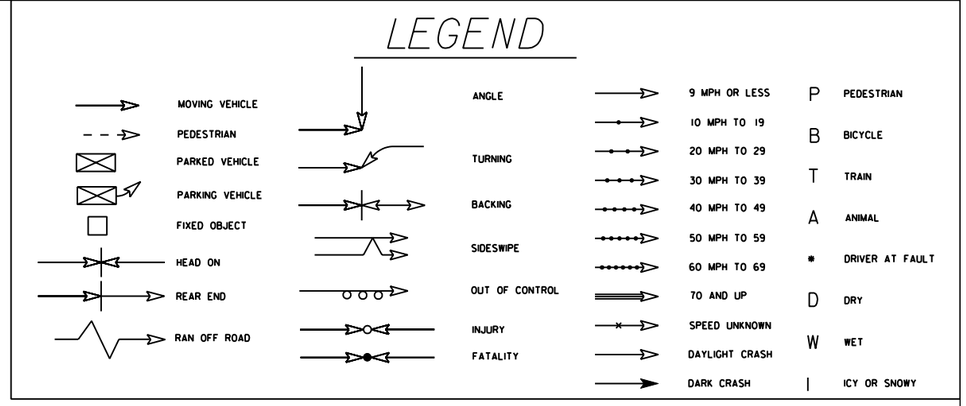
WESTBOUND RAMP

COLLISION DIAGRAM

DIVISION: 5	AREA: ..
STUDY PERIOD: 1/1/98 TO 5/31/02	
DISTANCE:	Y-LINE: ... FT
ANALYSIS PREPARED BY: CLS	
DIAGRAM PREPARED BY: CLS	
DIAGRAM REVIEWED BY:	
SCALE:	NOT TO SCALE
DATE:	8/15/07
LOG NUMBER:	200608079

N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH





SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Westbound Exit

Wake County

After Period

December 1, 2002 - April 30, 2007

TRAFFIC SAFETY SYSTEMS MANAGEMENT UNIT

HIGHWAY SAFETY IMPROVEMENT PROGRAM | SAFETY INFORMATION MANAGEMENT AND SUPPORT

SAFETY EVALUATION | TRAFFIC SAFETY

WESTBOUND RAMP

COLLISION DIAGRAM

DIVISION: 5	AREA: ..
STUDY PERIOD: 12/1/02 TO 4/30/07	
DISTANCE:	Y-LINE: ...FT
ANALYSIS PREPARED BY: CLS	
DIAGRAM PREPARED BY: CLS	
DIAGRAM REVIEWED BY:	
SCALE:	NOT TO SCALE
DATE:	8/15/07
LOG NUMBER:	20060807

N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH

SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Eastbound Exit

Wake County

Before Period

January 1, 1998 - May 31, 2002

LEGEND

MOVING VEHICLE
PEDESTRIAN
PARKED VEHICLE
PARKING VEHICLE
FIXED OBJECT
HEAD ON
REAR END
RAN OFF ROAD

ANGLE
TURNING
BACKING
SIDESWIPE
OUT OF CONTROL
INJURY
FATALITY

9 MPH OR LESS
10 MPH TO 19
20 MPH TO 29
30 MPH TO 39
40 MPH TO 49
50 MPH TO 59
60 MPH TO 69
70 AND UP
SPEED UNKNOWN
DAYLIGHT CRASH
DARK CRASH

P PEDESTRIAN
B BICYCLE
T TRAIN
A ANIMAL
* DRIVER AT FAULT
D DRY
W WET
I ICY OR SNOWY

SR 1664 (Blue Ridge Rd)

45 mph

SR 1728 (Wade Ave)

Eastbound Off Ramp

SR 1728 (Wade Ave)

Eastbound On Ramp

Hit phone line hanging in road

Trailer Crossed Centerline and Hit Vehicle

SR 1664 (Blue Ridge Rd)

45 mph

TRAFFIC SAFETY SYSTEMS MANAGEMENT UNIT

HIGHWAY SAFETY IMPROVEMENT PROGRAM | SAFETY INFORMATION MANAGEMENT AND SUPPORT

SAFETY EVALUATION | TRAFFIC SAFETY

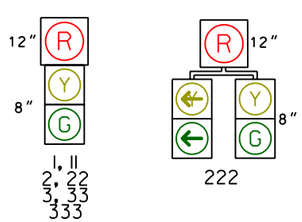
EASTBOUND RAMP

N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH

COLLISION DIAGRAM

DIVISION: 5	AREA: ..
STUDY PERIOD: 1/1/98 .. TO 5/31/02	
DISTANCE:	Y-LINE: ... FT
ANALYSIS PREPARED BY: CLS	
DIAGRAM PREPARED BY: CLS	
DIAGRAM REVIEWED BY:	
SCALE:	NOT TO SCALE
DATE:	11/16/07
LOG NUMBER:	200608079

SIGNAL FACE I.D.



SR 1664 (Blue Ridge Rd) at SR 1728 (Wade Ave) Eastbound Exit

Wake County

After Period

December 1, 2002 - April 30, 2007

LEGEND

- MOVING VEHICLE
- PEDESTRIAN
- PARKED VEHICLE
- PARKING VEHICLE
- FIXED OBJECT
- HEAD ON
- REAR END
- RAN OFF ROAD
- ANGLE
- TURNING
- BACKING
- SIDESWIPE
- OUT OF CONTROL
- INJURY
- FATALITY
- 9 MPH OR LESS
- 10 MPH TO 19
- 20 MPH TO 29
- 30 MPH TO 39
- 40 MPH TO 49
- 50 MPH TO 59
- 60 MPH TO 69
- 70 AND UP
- SPEED UNKNOWN
- DAYLIGHT CRASH
- DARK CRASH
- P PEDESTRIAN
- B BICYCLE
- T TRAIN
- A ANIMAL
- * DRIVER AT FAULT
- D DRY
- W WET
- I ICY OR SNOWY

SR 1728 (Wade Ave)

Eastbound Off Ramp

SR 1664 (Blue Ridge Rd)

45 mph

SR 1728 (Wade Ave)

Eastbound On Ramp

SR 1664 (Blue Ridge Rd)

45 mph

TRAFFIC SAFETY SYSTEMS MANAGEMENT UNIT	COLLISION DIAGRAM
HIGHWAY SAFETY IMPROVEMENT PROGRAM / SAFETY INFORMATION MANAGEMENT AND SUPPORT	DIVISION: 5 AREA: ..
SAFETY EVALUATION / TRAFFIC SAFETY	STUDY PERIOD: 12/1/02 TO 4/30/07
	DISTANCE: ..... Y-LINE: ...FT
	ANALYSIS PREPARED BY: CLS
	DIAGRAM PREPARED BY: CLS
	DIAGRAM REVIEWED BY:
EASTBOUND RAMP	SCALE: NOT TO SCALE
	DATE: 11/16/07
	LOG NUMBER: 200608079

N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH

SIGNAL FACE I.D.

Denotes L.E.D.